Early Journal Content on JSTOR, Free to Anyone in the World

This article is one of nearly 500,000 scholarly works digitized and made freely available to everyone in the world by JSTOR.

Known as the Early Journal Content, this set of works include research articles, news, letters, and other writings published in more than 200 of the oldest leading academic journals. The works date from the mid-seventeenth to the early twentieth centuries.

We encourage people to read and share the Early Journal Content openly and to tell others that this resource exists. People may post this content online or redistribute in any way for non-commercial purposes.

Read more about Early Journal Content at http://about.jstor.org/participate-jstor/individuals/early-journal-content.

JSTOR is a digital library of academic journals, books, and primary source objects. JSTOR helps people discover, use, and build upon a wide range of content through a powerful research and teaching platform, and preserves this content for future generations. JSTOR is part of ITHAKA, a not-for-profit organization that also includes Ithaka S+R and Portico. For more information about JSTOR, please contact support@jstor.org.

THE
JOURNAL OF GEOLOGY

JANUARY–FEBRUARY 1907

A DRAINAGE PECULIARITY OF THE SANTA CLARA VALLEY AFFECTING FRESH-WATER FAUNAS

J. C. BRANNER

In 1890 Professor Joseph Le Conte read before the Geological Society of America an article on Tertiary and post-Tertiary changes of the Atlantic and Pacific coasts, in which he expressed the opinion that the drainage of the great valley of California formerly flowed into the Pacific Ocean, not through the Golden Gate as it does now, but by way of the Santa Clara Valley and the Bay of Monterey.[1] His reasons for this theory are: (1) that there is no submerged channel off the Golden Gate; (2) that there is a submerged valley off the Bay of Monterey, while (3) the watershed between the north end of the Santa Clara Valley and that now flowing into Monterey Bay by way of the Pajaro River is less than a hundred feet high at its lowest point. A few years later Dr. C. H. Gilbert, professor of zoölogy at Stanford University, in studying the fishes of California, observed a remarkable resemblance between certain fishes found in the Sacramento drainage and in the streams flowing into the Bay of San Francisco, and those found in the Pajaro, Salinas, San Lorenzo, and other streams flowing into the Bay of Monterey. The fishes here referred to are not of kinds that descend into salt water; their present distribution therefore cannot be explained by that kind of migration. It can only be accounted for by some ancient direct connection between the streams in question. This work has been greatly extended by

---

[1] *Bulletin of the Geological Society of America*, Vol. II (1891), p. 326.

Professor Snyder, of the Department of Zoölogy, Stanford University.[2]

In accounting for the distribution of these fishes, the theory of Dr. Le Conte seemed to meet the requirements of the case fairly well. To understand the principal peculiarities of this fauna, it was only necessary to imagine the Golden Gate closed and the Sacramento Valley drainage flowing down the Santa Clara Valley and emptying into the Bay of Monterey. The Bay of San Francisco would thus be a body of fresh water, and the fishes of the upper Sacramento could ascend streams flowing into the fresh-water bay and into the Santa Clara Valley. There is some difficulty in comprehending how the fishes from the Pajaro, through which the waters are supposed to have entered the Bay of Monterey, could get into the Salinas a few miles to the south, and into the San Lorenzo which enters the bay twelve miles or more northwest of the mouth of the Pajaro; but no stress need be laid just now on the relation of the Pajaro to other streams flowing into the Bay of Monterey. Recent study of the geology southwest of San José has raised serious doubt regarding Dr. Le Conte's conclusions and necessitated a closer scrutiny of the facts offered in their support.

The first two reasons brought forward by him—namely, (1) that there is no submerged channel in front of the Golden Gate, and (2) that there is such a channel in the Bay of Monterey—are sufficiently warranted by the hydrographic charts. The Monterey channel is clearly exhibited in one of the charts accompanying Professor George Davidson's "Submerged Valleys of the Coast of California," published in the *Proceedings of the California Academy of Sciences*, Third Series, Vol. I, pp. 73–101, S. F. 1897. The question is here raised, however, regarding the assumed height of the watershed in the Santa Clara Valley between the drainage into the Bay of San Francisco and the drainage into the Bay of Monterey. Dr. Le Conte says it is less than a hundred feet above sea-level, and it is apparently assumed that with the Golden Gate closed the drainage of the great valley would rise and flow over this notch and pass down the Pajaro River to the Bay of Monterey.

---

[2] J. O. Snyder, "Notes on the Fishes of the Streams Flowing into San Francisco Bay, Cal.," *Report of the U. S. Fish Commission*, 1904.

The line of the Southern Pacific Railway passes over the watershed referred to at Madrone station, and the elevation at that place, as officially published, is 345 feet.[1] This elevation, though much greater than was supposed, would not alone, however, seriously interfere with Dr. Le Conte's theory. But if we imagine the Golden Gate closed, it is necessary, in order to test the validity of the hypothesis, to know where the lowest gaps are through which the water could escape to the sea. If the Madrone saddle, even with an elevation of 345, is the lowest pass to the ocean, then of course the water would flow out that way. But the Coast Survey's topographic map of San Francisco shows that, if the present Golden Gate were closed and the water compelled to find a new outlet, it would first flow over the divide at Colma seven miles south of the City Hall of San Francisco; this gap has an elevation of only 190 feet above tide. North of San Francisco it would also flow into the sea from Richardson Bay near Sausalito by way of Elk Valley, which has a watershed only 190 feet above tide-level.

Without further inquiry into the existence of other low divides between the bay and the ocean, it is evident that, even if it were admitted that the Golden Gate be a late topographic development, the Sacramento drainage did not lately flow into the Bay of Monterey by way of the Santa Clara Valley. It is evident also that the resemblance between the fish faunas of the Sacramento drainage and the streams flowing into Monterey Bay must be sought elsewhere.

The accompanying map shows in a general way the present drainage of the Santa Clara Valley in the vicinity of Madrone. Attention is directed to Coyote Creek, which emerges from the Mount Hamilton range opposite Madrone station and flows northwestward into the Bay of San Francisco. This stream, above where it emerges from the hills on to the plains, drains an area of 214 square miles, much more than any other one stream that enters the Santa Clara Valley. From the mouth of the gorge where this creek debouches on the plain a great alluvial fan spreads out toward the south and west across the entire width of the Santa Clara Valley, at this place a distance of two and a half miles. This fan forms the watershed in the valley trough between the Bay of San Francisco and the Pajaro River or

---

[1] Gannett's *Dictionary of Elevation*, p. 220.

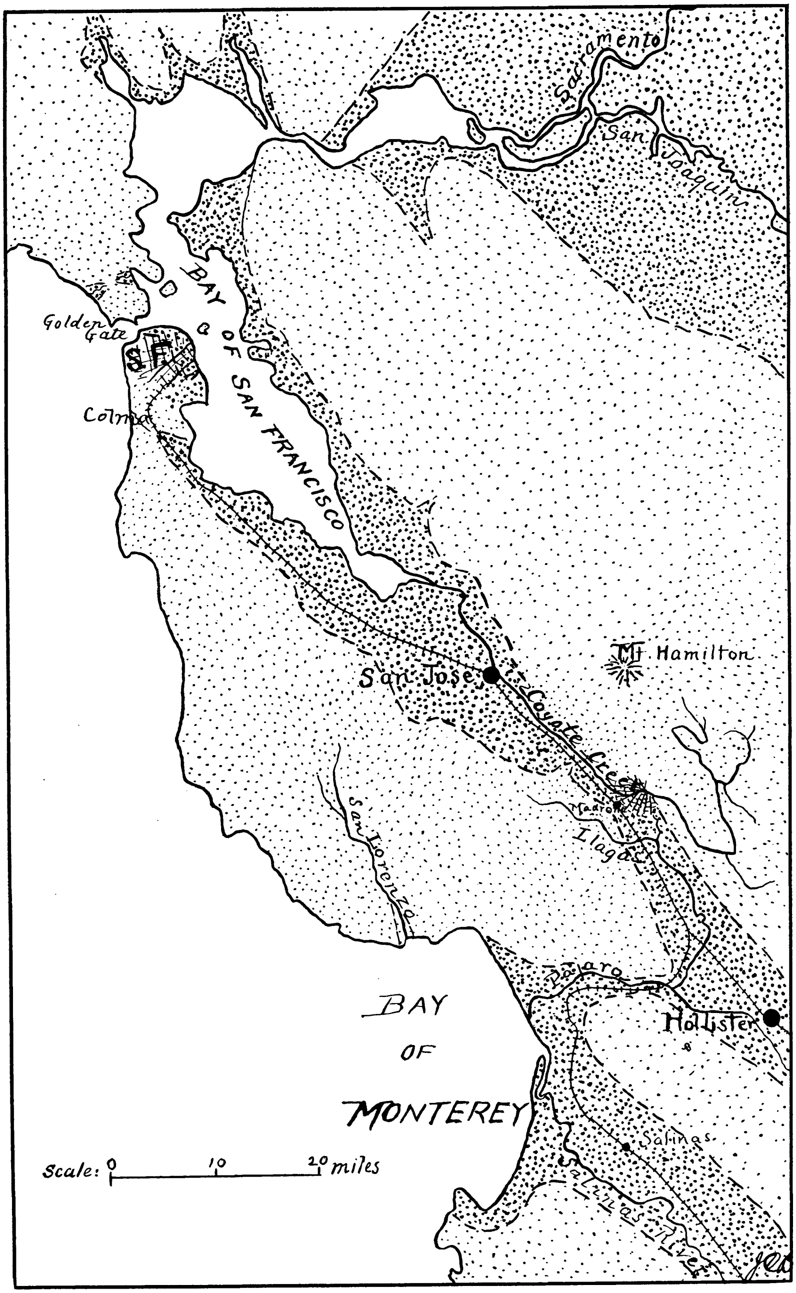

FIG. 1.—Map showing the relations of the drainage about the Bay of San Francisco and the Bay of Monterey. The more heavily shaded areas represent the flat valley lands.

the Bay of Monterey. Madrone station on the Southern Pacific Railway is at the southwestern edge of this alluvial fan, and is on the watershed at its lowest point. It will be seen from the map that upon emerging from the hills Coyote Creek bends sharply to the right and flows close to Las Animas Hills for several miles. The configuration of the materials of the alluvial fan at the mouth of the gorge shows that the Coyote has been shifting its channel of late. A terrace south of the stream, and approximately parallel with it, shows that it formerly flowed toward the west, while another and still higher terrace farther south shows that at an earlier date it flowed toward the southwest; and the general form of the alluvial fan shows that the whole fan was built by the Coyote. It is a characteristic feature of streams, in the building-up of such deposits, that they swing from side to side, flowing down over their own deposits in every direction, and shifting their channels as they become choked up by the deposit of their excess of load. The depth and position of the channel through which the Coyote now flows after emerging from the hills show that there has been no recent discharge of its waters toward the Pajaro. The general topography of the region about the mouth of the gorge suggests that the alluvial fan was built up a long while ago, and at a period when the stream was much more active than it now is—possibly during or toward the close of the glacial epoch. During the glacial epoch the streams of the region were much more vigorous than they have been since, for the coast stood at an elevation of two thousand feet or more higher than it does at present. There was therefore a greater precipitation, and during the winter months the Mount Hamilton Range must have been covered with snow which accumulated more than it does now and went off rather suddenly with the warm rains of early spring, producing much greater floods than we now have.

It follows from the form of this alluvial fan on the plain where the stream emerges from the mountains that the Coyote must have shifted from side to side in the usual fashion, especially in the early history of the alluvial cone and during the constructive period. It flowed sometimes toward the northwest, draining into the Bay of San Francisco, and at other times toward the southeast, draining through the Pajaro into the Bay of Monterey. Such a shifting of the Coyote at the summit of the watershed would, in this fashion, afford an opportunity for the mingling of the fauna of the Pajaro and its tributaries with that of Coyote Creek and its tributaries. Fishes from the Pajaro could ascend the stream into the mountains while the water flowed toward the Pajaro, and when the stream shifted, or its waters divided, these fish could descend the Coyote.[1]

But the problem of the mingling of the fish faunas is not confined to the Pajaro and Coyote alone; it extends to the Sacramento and other streams flowing into the Bay of San Francisco and to other streams flowing into the Bay of Monterey. So long as the Bay of San Francisco is filled with salt or brackish water it is an effective barrier against the passage of these fishes.

The additional requirements of the case seem to be met by the theory of a former elevation of the coast. Indeed, not only does such a theory afford a satisfactory explanation of the mingling of the fish faunas of the streams under consideration, but it is necessary for the explanation of other phenomena more or less directly connected with this subject. That there was such an elevation is shown not only by (1) the mingling of the fish faunas of the streams referred to, and which I am unable to account for in any other way; but also by (2) the greater activity of the streams of the coast at a period not far removed geologically; by (3) the submerged valleys along the coast; and by (4) the islands off the California coast.

It is not proposed to discuss these evidences at length, but a few words may be said of the importance of each one. The evidence of greater activity of the streams is not confined to the Coyote or to the streams of any particular district, but it is common to the streams of the Coast Range and of the Sierra Nevada. The great alluvial cones of the glacial epoch are far beyond the reach of the modern streams which are now cutting into them. In the Santa Clara Valley every considerable stream that enters it, whether from the Mount Hamilton or the Santa Cruz range, has a broad alluvial fan where it emerges on the plain. The same thing is true of the streams flowing into the San Joaquin Valley, whether from the Mount Hamilton or from the Sierra side. It may be objected that the theory of the greater activity of the streams requires a change of climate. But no change is assumed other than such as would be produced by an elevation of the region.

---

[1] The topographic peculiarity here cited is not unique. In 1892 Dr. B. W. Everman, in connection with the work of the U. S. Fish Commission, pointed out how fish may cross over the continental divide from the Columbia River basin to the Mississippi basin by way of Two-Ocean Pass. There is a similar low alluvial fan in a meadow on the watershed between the drainage of the Paraguay and of the Amazon basin. In both of these cases the watersheds permit the mingling of the existing fauna. (The Report of the Commissioner of Fish and Fisheries respecting the Establishment of Fish Cultural Stations in the Rocky Mountain Region and Gulf States, *Miscellaneous Senate Document*, No. 65, pp. 22–26 [Washington, 1892].)

The submerged valleys of the coast of California figured by Professor George Davidson in his paper on this subject[1] show that the coast must have stood much higher when those valleys were cut than it does at present. The reduced charts published by Professor Davidson in his article upon the submerged valleys of the coast show the following minimum elevations required in order that these valleys should again become dry land.

Near San Diego	over 3,600 feet
Near Santa Monica	over 1,200 “
Near Point Muger	over 2,400 “
East of Anacapa Island	about 1,800 “
Santa Catalina Island	over 1,800 “
Santa Cruz Channel	over 1,800 “
King Peak submerged valley, south of Cape Mendocino	over 2,400 “
Spanish Flat Valley, south of Cape Mendocino	over 1,800 “
Punta Gorda Valley, south of Cape Mendocino	over 3,500 “
Near Cape Mendocino	over 2,400 “
Carmel Bay	over 3,000 “
Monterey Bay	over 3,600 “

The dendritic topography of these submerged valleys shown by the hydrographic charts is so characteristic of land forms produced by stream erosions that there seems no escaping the conclusion that they were formed when the region was out of water. There are not always soundings enough to show the topography very far from the shore, and in all cases we seem to have discovered only the upper ends of these submerged valleys.

At the Bay of Monterey, Carmel Bay, and near San Diego, however, the submarine topography is best shown, and at these places there is suggested a former elevation of the land amounting to more than 3,000 feet. In other cases the depths of the dendritic contours are only from 1,200 to 2,000 feet, but in these instances the information regarding the former edge of the land appears to be imperfect. The absence of a submarine channel off the Golden Gate is probably due to the fact that the silts from the great valley have completely buried and obscured it.

---

[1] *Proceedings of the California Academy of Sciences*, 3d ser., "Geology," Vol. I (1897), pp. 73–103.

The separation from the main land of the coast islands, Santa Catalina, Santa Rosa, etc., was produced by a recent depression that left the tops of mountains or hills in the form of islands. This is suggested by the topography of the coast islands, and is borne out by the flora and fauna[1] of those islands. The finding of the remains of the mastodon upon the island of Santa Rosa marks[2] fairly well the period of the former elevation of the coast and of land connection between the present coast and those islands—that is, the separation took place in Pleistocene times.

The peculiarity of the fish faunas of certain streams referred to lies in the fact that in several cases the faunas show that streams which are now clearly separated were formerly connected. In most cases the former connection was apparently made possible by an elevation of the coast which permitted two or three streams to enter the ocean by a single mouth. It is assumed that at such time there was a single fauna in the entire river system. The later depression has submerged the mouth of the stream, and there are now two or three or more separate streams entering the sea through as many mouths, in place of a single system entering the ocean through one mouth.

In the theoretical case suggested by the accompanying figure it is clear that when the sea came up to the "old shore" line, fish could mingle throughout the entire drainage system represented. A depression that would place the "later shore" line as indicated would cut off the southernmost branch, but would leave the fishes free to move through the other branch of the river system. A depression bringing the water up to the "present shore" would separate the original single drainage system into five different systems, while the faunas would remain more or less the same as the one that occupied the ramifications of the streams when the drainage all entered the sea through a single mouth. It is to be expected that in time the faunas diverge, and that the longer they are separated, the greater the difference will be. The Coyote and Pajaro drainages have been separated since the streams ceased to be so active, and it seems quite reasonable to suppose that that period was at the close of the glacial epoch. The ichthyologists state that the fishes in the separate streams are already showing perceptible differences—differences that could only be expected after a long period of separation.

---

[1] John Van Denburgh, "The Reptiles and Amphibians of the Islands of the Pacific Coast of North America," *Proceedings of the California Academy of Sciences*, 3d ser., "Zoölogy," Vol. IV, No. 1. The author reports four amphibians, nineteen lizards, and six snakes (twenty-nine in all) on the islands, of which fifteen live on the mainland.

[2] Joseph Le Conte, "The Flora of the Coast Islands of California, etc.," *American Geologist*, Vol. I (1888), pp. 76–81; *Proceedings of the California Academy of Sciences*, Vol. V (1873), p. 152; *American Journal of Science*, 3d ser., Vol. XXXIV (1887), pp. 457–60. L. G. Yates, *American Geologist*, January, 1890, pp. 51, 52.

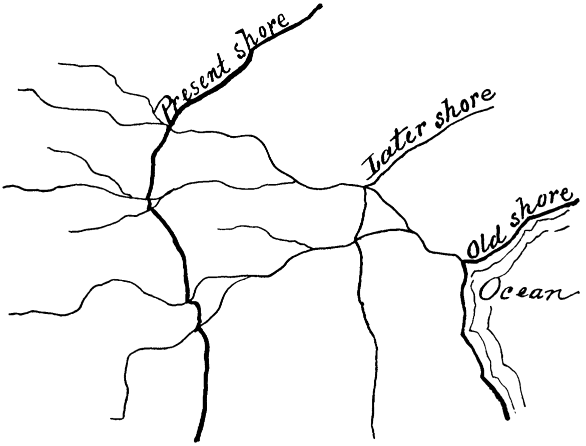

FIG. 2.—Theoretical case to illustrate the effect of coast depression on the fauna of streams that originally belonged to one system, but became separated by submergence.

Mention should be made of the finding of marine shells in wells put down on the plain northwest of San José. In the *Tenth Annual Report* of the State Mineralogist of California for 1890, p. 610, Mr. Watt says that "marine organisms have also frequently been met with." "Oyster shells" were obtained in a stratum of bluish sand, and a stratum of blue clay containing numerous "clam shells" is said to have been bored through about two miles north of Alviso. The finding of these marine deposits seems to show that the materials in the valley bottom are not of land origin. The deposits referred to might be either preglacial or postglacial without interfering with the theory of the elevation of the coast during the glacial epoch. In every instance, however, these marine shells have been found so near the present Bay of San Francisco that I am disposed to believe that the deposits containing them belong to the late history of the Bay and not to the more remote period.

Résumé.—The theory of the postglacial age of the Golden Gate does not appear tenable. The watershed at Madrone in the Santa Clara Valley between Coyote Creek and Pajaro River is not the lowest one between the Bay of San Francisco and the Pacific; the one at Colma is 155 feet lower, and another in Elk Valley is also 155 feet lower. The mingling of the fish faunas of streams flowing into the Bay of Monterey with those of streams entering the Bay of San Francisco is explained by the fact that Coyote Creek, descending into the Santa Clara Valley from the Mount Hamilton range at the crest of the watershed between the San Francisco Bay and the Bay of Monterey, formed an alluvial cone and swung from side to side, emptying part of the time into the Pajaro and part of the time into the Coyote. The passage of fishes between the various streams entering the Bay of San Francisco must have taken place at a time when the coast stood enough higher than it does at present to have emptied the Bay of San Francisco, and thus to have permitted fishes to descend from the Sacramento and ascend the Coyote and other streams without entering salt water. This same elevation would permit the passage of fishes between streams entering the Bay of Monterey.

It is believed that the elevation that united these streams occurred during the glacial epoch, and that it was the larger run-off of waters of that epoch that built up the alluvial cone where the Coyote debouches on the flat floor of the Santa Clara Valley.